

## Original Article

# Performance of nutritional screening tools in predicting poor six-month outcome in hospitalised older patients

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Malnutrition is a major problem in hospitalised older people. Many nutrition screening tools are available for malnutrition identification, however little is known about their prognostic ability. This prospective, observational study investigated the prognostic value of three nutritional screening tools in a Geriatric Evaluation and Management Unit: the Geriatric Nutritional Risk Index (GNRI), the Mini Nutritional Assessment (MNA) and the Mini Nutritional Assessment short form (MNA-SF), incorporating either body mass index or calf circumference. Poor six-month outcome was defined as new admission to higher level residential care or mortality at six months post-discharge. Predictive ability of poor outcome was assessed by logistic regression models, adjusting for age, gender, cognition and co-morbidity. Predictive accuracy was determined by area under Receiver Operator Characteristic curves, sensitivity, specificity, predictive values and Youden Index. One hundred and seventy-two consecutive patients with a mean (SD) age=85.2 (6.4) years were included in the study. Malnutrition was identified in 31% of patients using the MNA and was associated with a higher risk of poor six-month outcome when identified by the MNA (OR, 95% CI=3.29, 1.17-9.23) and the GNRI (OR, 95% CI=2.84, 1.31-6.19), but not by the MNA-SF. All screening tools lacked discriminative power for outcome prediction. The MNA and GNRI were useful clinical predictors of poor six-month outcome, although their accuracy of prediction was low. Nutritional screening remains a priority in the routine assessment of hospitalised older people.

**Key Words:** nutritional status, hospitalisation, aged, malnutrition, epidemiology

## INTRODUCTION

Malnutrition, a major problem associated with hospitalisation in older people, has an extensive impact on mortality and morbidity.<sup>1</sup> The incidence of malnutrition in hospitalised older people is high, with around 22-68% of patients diagnosed, depending on the population studied and the assessment method used.<sup>1</sup> Malnutrition, despite this high prevalence, often goes unrecognised in hospitals.<sup>2</sup>

Nutritional screening tests are at the forefront of identifying patients with malnutrition. Ideally, identified patients are referred for a full nutritional assessment, which includes diagnosis confirmation, and identification of specific nutritional deficits.<sup>3</sup> A nutritional screening tool has additional clinical and research value if it also doubles as an index of nutritional risk and, by definition, is able to predict the probability of an adverse outcome occurring.<sup>4</sup> Many nutritional screening tools exist, however, it is not yet clear which one performs best in predicting longer term outcomes in hospitalised older people.<sup>1</sup>

Three nutritional screening tools showing promise as indices of nutritional risk are the Mini Nutritional Assessment (MNA),<sup>5</sup> the MNA short form (MNA-SF)<sup>6</sup> and the Geriatric Nutritional Risk Index.<sup>7</sup> The MNA is specifically designed for, and extensively validated in older

people.<sup>3,5</sup> It includes 18 questions in four domains: subjective assessment, nutritional assessment, anthropometric assessment and general assessment.<sup>3</sup> The MNA shows prognostic ability in hospitalised older people,<sup>8-12</sup> although not all studies agree.<sup>10,13</sup> A simpler version of the MNA, the MNA-SF<sup>6</sup> may also have potential as an index of nutritional risk, although studies of its prognostic ability are limited.<sup>1</sup>

The Geriatric Nutritional Risk Index (GNRI) was initially developed as a nutrition-related risk index in older people, but has recently been validated as a nutritional screening tool in its own right.<sup>7</sup> The GNRI also shows promise as a predictor of morbidity and mortality in hospitalised older people.<sup>4,14</sup> However, its prognostic ability has only been compared to the MNA in one previous study, and that was conducted in residential care dwelling

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older people.<sup>7</sup>

The aim of this study was to investigate the predictive ability and accuracy of the MNA, MNA-SF and GNRI in determining poor six-month outcome in older people hospitalised in a Geriatric Evaluation and Management Unit (GEMU).

## METHODS

This was a longitudinal observational study of consecutive patients admitted to the 20-bed GEMU at The Queen Elizabeth Hospital (TQEH), South Australia. Patients were recruited between October 22, 2010 and December 23, 2011. The study was approved by the Human Research Ethics Committee (TQEH) and all patients (or authorised proxy) gave informed consent, in accordance with ethical standards from the 2000 Declaration of Helsinki. All patients received nutritional care, regardless of their nutritional status.

Data were collected from the patient (or proxy) in the first 72 hours of admission. Clinical information from patient records was also collected, including: diagnosis, biomarkers, Barthel's Index of Activities of Daily Living (scored out of 100),<sup>15</sup> Geriatric Depression Scale-Short Form (GDS-SF) (scored out of 15)<sup>16</sup> and cognition assessment by the Mini Mental State Examination (MMSE) (Scored out of 30).<sup>17</sup> Co-morbidity was evaluated using Charlson's Co-morbidity Index (CCI).<sup>18</sup> Patient height was measured to the nearest centimetre using a stadiometer, and for patients unable to stand independently, self-reported height was recorded. Weight was able to be measured in all patients using a calibrated weigh chair (FVCS-150) to two decimal points.

### Mini Nutritional Assessment (MNA)

The MNA is scored out of 30, with scores  $\geq 24$  considered to be well nourished, scores 17-23.5 as at risk of malnutrition and scores  $< 17$  as malnourished.<sup>3</sup> Inadequate nutrition (IN) was defined as either malnutrition or risk of malnutrition (scores  $< 24$ ).

### Mini Nutritional Assessment short form (MNA-SF)

The MNA-SF includes six questions of the MNA.<sup>6</sup> Two versions of the MNA-SF exist: one including body mass index (BMI) (the MNA-SF-BMI) and the other including calf circumference (CC) (MNA-SF-CC). For both MNA-SF versions, scores 0-7 points were considered as malnourished; scores 8-11 as at risk of malnutrition and scores 12-14 as well nourished.<sup>6</sup> IN was defined as scores  $< 12$ .

### Geriatric Nutritional Risk Index (GNRI)

GNRI is computed as follows:

$$\text{GNRI} = (1.489 \times \text{albumin (g/L)}) + (41.7 \times (\text{weight/WLo}))$$

With WLo=Ideal Weight, using Lorentz equations as described by Boulianne et al<sup>4</sup>:

$$\text{Men: WLo} = H - 100 - ((H - 150) / 4)$$

$$\text{Women: WLo} = H - 100 - ((H - 150) / 2.5)$$

With H=height in cm; g=grams; L=Litre

For the purposes of comparing the GNRI to the three categories of the MNA and MNA-SF, GNRI scores were placed into three categories as described previously:<sup>4,7</sup> severe/moderate risk (scores  $< 92$ ), low risk (scores 92-98)

and no risk (scores  $> 98$ ). IN was defined as scores  $\leq 98$ .

## Outcome

All patients (or proxy) were followed up at six months post-discharge by telephone interview and accessing the South Australian Health Department Open Architecture Clinical Information System system. Poor six-month outcome was defined as a composite measure of one or more of the following occurring: i) death ii) new admission to a residential care facility or ii) move from low level care to high level care within a residential care facility. A composite measure was chosen due to the impact of mortality on residential care admission.

## Statistics

Statistics were analysed using SPSS for Windows 19.0 (SPSS Inc., Chicago, IL). All statistical tests were two-sided, with  $p < 0.05$  used to indicate statistical significance. Data are presented as mean (standard deviation) or median (range) as appropriate. To compare differences in baseline clinical characteristics between patients with poor six-month outcomes and those with better outcomes, Chi-square tests were performed for categorical variables, t-tests were performed for normally distributed variables, and Mann-Whitney U tests were performed for non-normally distributed variables. The predictive ability of each nutritional screening tool was determined by logistic regression analyses, both unadjusted and adjusted for age, gender, cognition and co-morbidity.

When assessing predictive ability, it is also important to look at the accuracy of each screening tool in correctly identifying patients at risk of poor outcome.<sup>19</sup> In this study, predictive accuracy was assessed by sensitivity, specificity, predictive values (positive and negative), Youden Index (sensitivity + specificity - 1) and area under curve of Receiver Operating Characteristic (ROC) curves ( $\text{auROC}$ ). ROC curves were derived from predicted probabilities, and a value  $> 0.7$  was considered to indicate sufficient predictive accuracy.<sup>20</sup> Sensitivity values above 80% were deemed to be adequate prognostic accuracy in order to sufficiently avoid false negative tests.<sup>21</sup> Similarly, specificity values higher than 60% were considered satisfactory to avoid false positive screenings.<sup>21</sup>

## RESULTS

Of 427 new patients admitted to the GEMU during the study period, 172 were recruited. Exclusion reasons were: language barrier without proxy ( $n=67$ ), dementia or unresolved delirium within 72 hours of GEMU admission without proxy ( $n=77$ ), treating clinician advised against patient participation (elder abuse, physically aggressive or medically unwell:  $n=33$ ), infectious ( $n=11$ ), missed by researcher ( $n=4$ ) and did not wish to participate ( $n=63$ ).

During the six month follow-up period, including the period from the GEMU admission to hospital discharge, 78 patients encountered a poor outcome: 28 (16%) patients died, 48 (28%) moved into residential care (low or high level care) and 2 people (1%) moved from low level to high level care within a residential care facility. Table 1 shows patient admission characteristics. From this table it can be seen that patients who encountered a poor six-

month outcome were more likely to have lower cognition, a longer length of GEMU stay, and lower lymphocyte and iron levels.

The unadjusted and adjusted OR values for prediction of poor outcome are shown in Table 2. From this table it can be seen that, malnutrition classification at admission by the MNA, MNA-SF-CC, GNRI, but not the MNA-SF-BMI, predicted poor six-month outcome. After adjustment for age, gender, MMSE score and co-morbidity, MNA and GNRI classified malnutrition retained predictive their ability. For each screening tool, a classification of 'Risk of Malnutrition' was not associated with poor six-month outcome using either adjusted or unadjusted

analyses.

From Table 3 it can be seen that the malnourished categories for MNA and MNA-SF-BMI achieved satisfactory specificity values (>60%). However, the sensitivity values for the malnutrition categories of each screening tool were below adequate (<80%). Overall, both positive and negative predictive values were low-moderate for each screening tool. The MNA showed the highest predictive accuracy overall (indicated by its higher values for  $a_{u}ROC$  and Youden Index). However, the  $a_{u}ROC$  value for all nutritional screening tools, including the MNA, lacked adequate predictive accuracy ( $a_{u}ROC < 0.7$ ).

**Table 1.** Baseline characteristics of patients on admission (n=172)

Variable	n (%)	Poor six-month outcome (n=78)	Good six-month outcome (n=94)	<i>p</i>
Gender (female)	123 (71)	53 (68)	70 (75)	0.066
Age as of admission <sup>†</sup>	85.2 (6.4)	85.9 (6.7)	84.6 (6.1)	0.273
Length of GEMU stay <sup>‡</sup>	2 (1-91)	16 (1-75)	10 (1-91)	0.001
Length of acute hospital stay before GEMU <sup>‡</sup>	4 (0-53)	4 (0-53)	4 (0-22)	0.072
Depression symptoms (GDS-SF) <sup>†</sup>	4.5 (3.4)	4.9 (3.6)	4.1 (3.1)	0.077
Cognition (MMSE Score) <sup>†</sup>	23.2 (5.6)	20.9 (5.8)	24.9 (4.8)	<0.001
Admission function (Barthel's Index) <sup>†</sup>	58.6 (21.1)	53.9 (19.8)	62.6 (21.6)	0.304
Medication number <sup>†</sup>	9.6 (4.3)	9.2 (4.6)	10.0 (4.1)	0.313
Calf circumference (cm) <sup>†</sup>	31.8 (5.0)	30.7 (5.3)	32.8 (4.6)	0.474
BMI (kg/m <sup>2</sup> ) <sup>†</sup>	25.3 (6.5)	23.6 (6.3)	26.6 (6.5)	0.406
Charlson's Co-morbidity Index	3.0 (2.3)	3.2 (2.4)	2.9 (2.2)	0.479
<b>Biomarkers<sup>‡</sup></b>				
Folate (nmol/L)	23.5 (0-1377)	23.0 (0-434)	24.3 (5-1377)	0.468
CRP (mg/L)	17.0 (0.5-320)	21.0 (0.6-170)	14.5 (0.5-320)	0.218
Albumin (g/L)	31.0 (17-41)	30.0 (21-41)	31.0 (17-37)	0.407
Creatinine (µmol/L)	83.5 (4-239)	83.5 (49-239)	83.5 (4-201)	0.270
Lymphocyte (g/L)	1.29 (0.40-188)	1.05 (0.40-188)	1.49 (0.53-4.3)	<0.001
Iron stores (µmol/L)	10.0 (1-201)	9.0 (1-201)	11.0 (2-64)	0.009
Vitamin B <sub>12</sub> (pmol/L)	305 (7-1476)	330 (92-1476)	283 (7-1450)	0.482
25OH vitamin D (nmol/L)	64.0 (14-151)	70.0 (15-151)	61.5 (14-149)	0.322
Haemoglobin (g/L)	120 (79-162)	117 (83-162)	121 (79-153)	0.101

GEMU: Geriatric Evaluation and Management Unit; MMSE: Mini Mental State Examination; GDS-SF: Geriatric Depression Scale short form; BMI: body mass index; CRP: C-reactive protein.

<sup>†</sup>Mean (standard deviation); <sup>‡</sup>Median (range).

**Table 2.** Odds ratios for prediction of poor six-month outcome by nutritional screening tool assessment on admission to the geriatric evaluation and management unit (n=172)<sup>†</sup>

Nutritional screening tool	Poor 6 month outcome unadjusted (n=78)			Poor 6 month outcome adjusted <sup>‡</sup> (n=78)		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
<b>MNA</b>						
Malnourishment (scores <17)	3.73	1.52-9.17	0.004*	3.25	1.16-9.13	0.026*
Risk of malnutrition (scores 17-23.5)	1.12	0.49-2.56	0.786	1.16	0.45-2.99	0.763
<b>MNA-SF-BMI</b>						
Malnourishment (scores <8)	1.78	0.74-4.26	0.197	1.51	0.55-4.14	0.424
Risk of malnutrition (Scores 8-11)	0.65	0.26-1.61	0.354	0.80	0.29-2.22	0.667
<b>MNA-SF-CC</b>						
Malnourishment (scores <8)	2.60	1.06-6.40	0.037*	2.18	0.81-5.91	0.124
Risk of malnutrition (scores 8-11)	0.94	0.35-2.53	0.944	1.31	0.49-3.51	0.595
<b>GNRI</b>						
Severe/moderate risk (scores <92)	2.21	1.13-4.31	0.021*	2.86	1.31-6.23	0.008*
Low risk (scores 92-98)	1.96	0.76-5.06	0.167	1.64	0.53-5.03	0.388

<sup>†</sup>Poor six-month outcome=mortality, new admission to a residential care facility or move from low level care to high level care within a residential care facility.

<sup>‡</sup>Adjusted for age, gender, Charlson's Comorbidity Index and MMSE score.

MNA: Mini Nutritional Assessment; MNA-SF-BMI: Mini Nutritional Assessment short form (body mass index version); MNA-SF-CC: MNA-SF (calf circumference version); GNRI: Geriatric Nutritional Risk Index.

\**p*<0.005.

**Table 3.** Prognostic ability of nutritional screening tools as predictors of poor six-month outcome (n=172)<sup>†</sup>

Nutritional screening tool	Prevalence n (%)	Died, n (%)		Se	Sp	PPV	NPV	YI	auROC (95 % CI)	p (auROC)
		Yes	No							
<b>MNA</b>										
Scores <17 (Mal)	53 (31)	35 (66)	18 (34)	44.9	80.9	66.0	63.9	25.7	0.634 (0.55-0.72)	0.003
Scores <24 (IN)	137 (80)	66 (48)	71 (52)	84.6	24.5	48.2	65.7	9.1		
<b>MNA-SF</b>										
Scores <8 (Mal)	77 (55)	44 (57)	33 (43)	56.4	64.9	57.1	64.2	21.3	0.610 (0.54-0.70)	0.007
Scores <12 (IN)	144 (84)	66 (46)	78 (54)	84.6	17.0	45.8	57.1	1.6		
<b>MNA-SF-CC</b>										
Scores <8 (Mal)	92 (53)	52 (57)	40 (44)	66.7	57.4	56.5	67.5	24.1	0.622 (0.54-0.71)	0.006
Scores <12 (IN)	145 (84)	69 (48)	76 (52)	88.5	19.1	47.6	66.7	7.6		
<b>GNRI</b>										
Scores <92 (Mal)	83 (48)	44 (56)	39 (47)	56.4	58.5	53.0	61.8	14.9	0.592 (0.51-0.68)	0.038
Scores ≤98 (IN)	107 (62)	56 (52)	51 (48)	71.8	45.7	52.3	66.2	17.5		

<sup>†</sup>Poor six-month outcome=mortality, new admission to a residential care facility or move from low level care to high level care within a residential care facility. A poor six-month outcome occurred in 78 patients.

auROC: Area under Curve of Receiving Operating Characteristic; MNA: Mini Nutritional Assessment; MNA-SF: Mini Nutritional Assessment short form; GNRI: Geriatric Nutritional Risk Index; PPV: Positive Predictive Value; NPV: Negative Predictive Value; Mal: malnourished; IN: inadequate nutrition; Se: Sensitivity; Sp: Specificity; YI: Youden Index.

## DISCUSSION

In this study of older people hospitalised in a GEMU, malnutrition was common on admission, ranging from 31-48% depending on the nutritional screening tool used. This high incidence of malnutrition is consistent with previous studies of hospitalised older people.<sup>12,13,22</sup> This study evaluated the ability of nutritional screening tools to predict a poor six-month outcome in GEMU patients. Malnutrition identified by the MNA, MNA-SF-CC, GNRI, but not the MNA-SF-BMI was associated with poor six-month outcome. However, after adjustment for confounding variables (age, gender, cognition and comorbidity), only MNA and GNRI maintained their predictive ability. Risk of malnutrition classification failed to predict poor six-month outcome for all screening tools.

Very few studies to date have compared MNA and GNRI with respect to adverse outcome prediction in the hospital setting. In the residential care setting, a malnutrition classification by either GNRI and MNA was found to be predictive of mortality, infection and bedsores.<sup>7</sup> Their study was inconclusive as to which screening tool performed best, although the GNRI appeared to outperform the MNA when all adverse complications were pooled together.<sup>7</sup> In our study, malnutrition identified by the MNA showed higher predictive ability of poor six-month outcome than the GNRI (adjusted OR values of 3.29 and 2.84 for MNA and GNRI respectively). This higher predictive ability of the MNA was perhaps because the MNA contained more nutrition-related risk components such as self-reported health, living status and neuropsychological problems than did the GNRI.<sup>3</sup> Malnourishment by the MNA is generally considered to be predictive of mortality,<sup>8-11</sup> although not all studies agree.<sup>10,13,19</sup>

In the present study, risk of malnutrition classification for all nutritional screening tools failed to predict poor six-month outcome. This finding does not indicate a person with an 'at risk' classification will avoid encountering a poor outcome. It could very well be that GEMU intervention, which includes Comprehensive Geriatric Assessment, multidisciplinary assessment and therapy, could have possibly helped prevent a poor outcome.<sup>23</sup> Indeed, an 'at risk' classification by the MNA has been found not

to be associated with morbidity in hospitalised older people,<sup>13</sup> although in community based studies, some studies have found an association<sup>24,25</sup> whilst others have not.<sup>26</sup>

With respect to accuracy of prediction, all screening tools in the present study failed to show sufficient prognostic accuracy (all auROC values <0.7). This lack of predictive accuracy disagrees with a study of hospitalised older people in which MNA showed adequate predictive accuracy for mortality prediction (auROC>0.7).<sup>13</sup> It could perhaps be that our shorter length study and combination measure of mortality and admission to residential care diminished the accuracy of MNA. There are no other studies, to our knowledge, looking at predictive accuracy of nutritional screening tools in hospitalised older people.<sup>1</sup>

Specificity values for malnutrition classifications of both MNA and MNA-SF-BMI were both above satisfactory levels to avoid false positive classifications for outcome prediction (>60%). However, malnutrition classifications for MNA-SF-CC and GNRI failed to reach this level. Moreover, sensitivity values for the malnutrition categories of all screening tools failed to reach adequate levels for prognostic accuracy (<80%) indicating the high likelihood of false negative classifications for outcome prediction.<sup>21</sup> Thus all nutritional screening tools assessed in our study should be interpreted with caution in adverse outcome prediction.

Study strengths were the inclusion of consecutive patients, the comprehensive admission data and the limited inter-tester bias. This study also recruited many patients with dementia and focused on the oldest old: both areas of growing research interest with the global expansion of the older demographic. Notwithstanding these strengths, our study had limitations. Our sample size was small and there was potential collection bias introduced by the use of a proxy to answer questions for patients with cognitive impairment and/or language barriers. Our analyses also did not account for nutritional support received by patients during and after hospitalisation. A further limitation is that our results only included GEMU patients and future studies should focus on multiple hospital wards with larger sample sizes.

## Conclusion

Malnutrition was frequent in GEMU patients. The MNA and GNRI were useful clinical predictors of poor six-month outcome, although their accuracy of prediction was low. Nutritional screening remains a priority in the routine assessment of hospitalised older people.

## AUTHOR DISCLOSURES

R Visvanathan has received grant funding from Vincent Fairfax Family Foundation (Royal Australasian College of Physicians), Faculty of Health Sciences, University of Adelaide Bernie Lewis Foundation (The Hospital Research Foundation at TQEH). R Visvanathan has previously received funding from Nestle and is currently on the Nestle Nutrition Australia Malnutrition In The Elderly Advisory Group. E Dent received a PhD scholarship funded by the National Health and Medical Research Council funded Centre for Research Excellence in Translating Nutritional Science to Good Health (CRE) for which I Chapman is a chief investigator.

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## Original Article

## Performance of nutritional screening tools in predicting poor six-month outcome in hospitalised older patients

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### 营养筛查工具在预测住院老年患者六个月预后不良的应用

营养不良是住院老年人最大的问题。许多营养筛查工具可用于营养不良鉴别，但很少有人知道他们的预测力。本前瞻性观察研究调查了在老年医学评估和管理处三个营养筛查工具：老年营养风险指数（GNRI），迷你营养评估（MNA）和迷你营养评估简化版（MNA-SF），结合 BMI 或小腿围的预测价值。六个月预后不良定义为出院六个月后以更高层次的居住护理重新入院或者死亡。用 Logistic 回归模型评估校正年龄、性别、认知和合并症后，其对预后不良的预测力。用受试者特征工作曲线下面积、灵敏度、特异度、预测值和 Youden 指数确定其预测精度。本研究纳入了 172 例长期病人，平均年龄为 85.2±6.4 岁。用 MNA 确诊 31% 的患者有营养不良，较高的六个月预后不良的风险与用 MNA（OR, 95% CI=3.29, 1.17-9.23）和 GNRI（OR, 95% CI=2.84, 1.31-6.19）确诊的营养不良与有关，但与 MNA-SF 确诊的营养不良无关。所有的筛查工具缺乏对结果预测的分辨力。MNA 和 GNRI 是六个月不良预后有用的临床预测工具，虽然他们的预测精度较低。营养筛查仍然是住院老年人优先的常规评估项目。

**关键词：**营养状况、住院、老年的、营养不良、流行病学